(12) UK Patent Application (19) GB (11) 2 272 969 (13) A

(43) Date of A Publication 01.06.1994

(21) Application No 9222106.8

(22) Date of Filing 21.10.1992

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(51) INT CL^5
F24H 7/00

(52) UK CL (Edition M)
F4U UEA

(56) Documents Cited
GB 1538533 A US 4504402 A

(58) Field of Search
UK CL (Edition L) F4U UEA UEB UEE U6234 U6235
INT CL^5 F24H 7/00 7/02 7/04, F24J 2/34 3/00
Online databases:WPI

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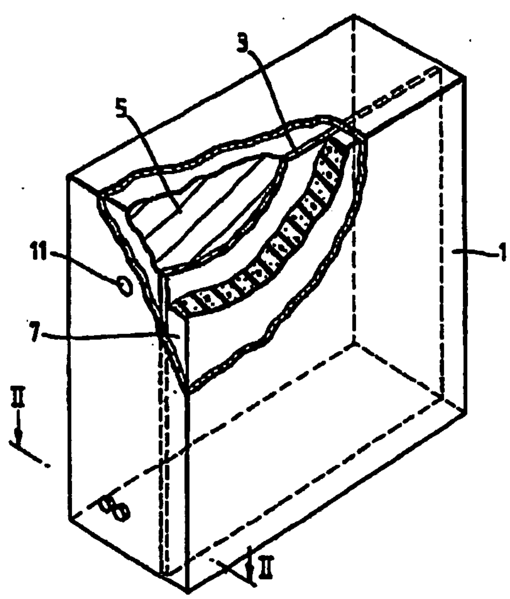
(54) Thermal storage device

(57) A thermal storage heater employing phase change material (PCM) as the storage material. A mass of this material, which crystallises as the temperature falls to give out heat of crystallisation, is contained in a housing on one interior face of which a sheet or slab of foamed silicone rubber is fitted. Electric elements supply heat to the PCM during a low price period and the heat is given out during a high price period. As the PCM passes through its phase change it increases in volume in assuming the crystalline phase. This volume increase is accommodated by the resilient silicone rubber. The sheet of silicone rubber may be separated from the PCM by a sheet of metal.

Fig. 1.



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

Fig.1.

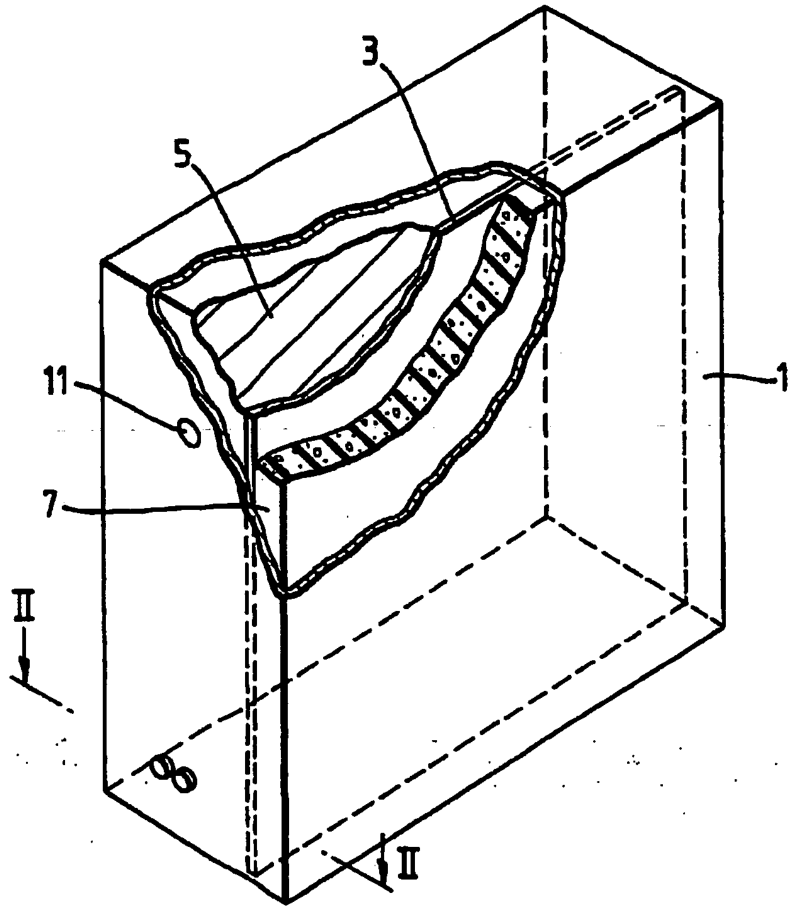
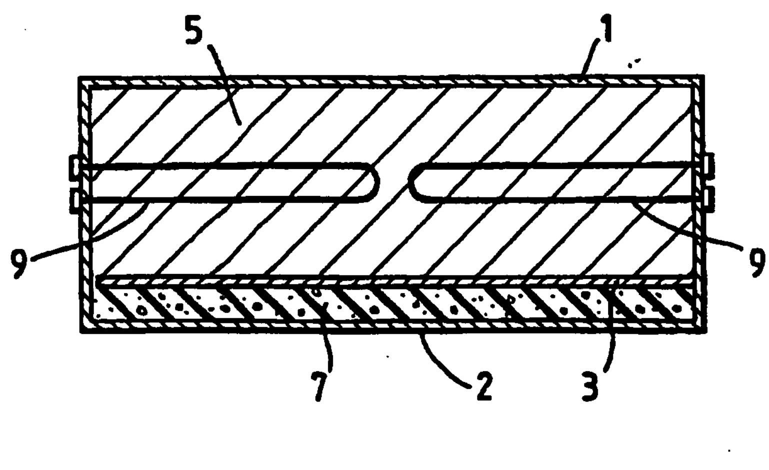


Fig.2.



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Thermal Storage Device

This invention relates to thermal storage devices for domestic and other environments where space heating is required. Heat storage devices employing so called 'phase change materials' are known in which advantage is taken of that property of the phase change material (PCM) whereby, as the material cools, it crystallises and gives out heat. This heat of phase change is in addition to its conventional heat storage properties in each of its two phases. Some known PCMs are:

sodium pyrophosphate decahydrate
sodium acetate trihydrate, barium
hydroxide octahydrate

While the material is crystalline in its lower temperature state it is in the form of a semi-solid pasty mass in its higher temperature state. One disadvantage of PCMs as heat storage materials is their change of volume occurring with the phase change, and to a lesser extent, in each of their two phase states as well.

The present invention is directed to accommodating this volume change in a novel and advantageous manner.

According to the present invention, a thermal storage device comprises a housing containing a phase change material in bulk, the housing also containing a resilient material which is adapted to contract and expand to accommodate expansion and contraction of the phase change material.

The resilient material may be in the form of a sheet or slab. The housing may be rectangular and the resilient material may then extend over one internal wall of the housing.

A metal sheet may separate the resilient material from the phase change material.

The resilient material may have at least one surface shaped to reduce the stiffness in a direction normal to said surface. Alternatively the resilient material may be formed to entrap pockets of air to increase its thermal insulation.

The phase change material may be, for example, sodium acetate trihydrate and the resilient material may be foamed silicone rubber.

A thermal storage device in accordance with the invention will now be described, by way of example, with reference to the accompanying drawings, of which:

Figure 1 is a perspective view of the device, partly broken away;

and Figure 2 is a plan view in the plane II-II of Figure 1.

The storage heater comprises a sheet metal housing 1 of rectangular form the interior of which is divided into two sections by a sheet metal partition 3. The major section of the enclosure is filled with a phase change material 5, eg sodium pyrophosphate decahydrate or sodium acetate trihydrate. The minor section, which occupies the rear of the enclosure, is filled with a sheet or slab of foamed silicone rubber 7 to which the sheet metal partition 3, is bonded. The partition 3 so mounted on the silicone rubber sheet may be left 'floating', ie un-anchored, within the housing 1. Alternatively it may be fixed along one edge to the housing 1 to allow movement transverse to its surface over most of the surface.

The basic purpose of the partition 3 is to separate the PCM 5 from the resilient material 7 where there may be some chemical interaction between the PCM and the material 7. Superior resilient materials such as foamed silicone rubber are less likely to interact with the PCM and in such cases the partition may be omitted and the PCM allowed to bear directly on the resilient material.

In an alternative arrangement the partition 3 may be of metal foil bonded to the material 7 and effectively carried by it.

The sheet of resilient material 7 typically has high thermal resistance and provides good insulation between the hot PMC and the rear surface 2 of the housing 1. This factor is of considerable value where the storage heater is to be operated in a situation where it backs on to a wall and the wall, or wall surface, is vulnerable to heat.

The sheet of resilient material can be formed or shaped in such manner as to enhance this protection. It may for example be corrugated or indented so as to trap air in pockets against the interior of the rear wall 2 of the housing or against the partition sheet 3. Alternatively the sheet, which inherently contains air or gas bubbles of sizes between zero and something of the order of a millimetre, may be formed with bore holes moulded into it.

The arrangement in which the PCM bears directly, or by means of a flexible membrane, on the resilient material 3, and without the intervening metal sheet has an advantage in that, if the phase change in the bulk material 5 does not occur uniformly throughout its mass the expansion/contraction will also not be uniform and the absence of a pressure-spreading metal sheet will allow the resilient material 7 to make local accommodation.

Towards the base of the storage heater, electric elements 9 are fitted to the housing 1 to project into the bulk of PCM 5. Towards the top of the storage heater a thermostat is fitted at one side (from location 11 on the housing) and a cut-out (not shown) in the corresponding position on the other side, the thermostat and cut-out extending towards each other.

In operation, the elements 9 are energised during a 'cheap' period in the day. As the bulk of PCM heats up it reaches its phase change temperature and changes phase from crystalline structure to an amorphous pasty mass without a significant rise in temperature. This physical change is accompanied by a reduction in volume which may be considerable.

At this point the foamed silicone rubber, which was compressed below the phase change, returns to or towards its natural volume. With further heat input the mass 5 absorbs and stores further heat while expanding slowly. Heat input is limited by the thermostat, and if necessary by the cut-out, the heat content of the bulk PCM being topped up throughout the 'on' period.

During the 'supply-off' period the bulk PCM loses heat to its environment through the front surface the sides and the top, but to a very much smaller extent through the sheet of silicone rubber 7 on the rear surface. As mentioned above, any wall against which the heater is positioned is not then subjected to any significant amount of heat.

At the peak temperature of the bulk PCM its volume will be such as to compress the silicone rubber 7 moderately, bu way of the metal sheet 3. As the temperature falls, the volume decreases slightly until at the crystallisation temperature the bulk of PCM paste crystallises and undergoes a significant increase in volume. It is at this point that the silicone rubber takes full effect. It is compressed by the partition sheet 3 or by the direct pressure of the PCM on it, the gas bubbles in the silicone rubber foam permitting compression of the foam with little resistance. Distortion of the housing 1 is thus avoided.

The crystallised PCM continues to lose heat until its temperature falls to that of the environment.

A very efficient thermal storage heater is thus provided and which is not subject to distortion of the body.

CLAIMS

1. A thermal storage device comprising a housing containing a phase change material in bulk, the housing also containing a resilient material which is adapted to contract and expand to accommodate expansion and contraction of the phase change material.

2. A device according to Claim 1, wherein said resilient material is in the form of a sheet or slab.

3. A device according to Claim 2, wherein said housing is rectangular and the resilient material extends over one internal wall of the housing.

4. A device according to Claim 3, wherein a metal sheet separates the resilient material from the phase change material.

5. A device according to any of Claims 2, 3 and 4, wherein said resilient material has at least one surface shaped to reduce the stiffness in a direction normal to said surface.

6. A device according to any of Claims 2 to 5, wherein said resilient material is formed to entrap pockets of air to increase its thermal insulation.

7. A device according to any preceding claim, wherein said phase change material is sodium acetate trihydrate

8. A device according to any preceding claim wherein said resilient material is foamed silicone rubber.

9. A thermal storage device substantially as hereinbefore described with reference to the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number

GB 9222106.8

Relevant Technical fields

(i) UK Cl (Edition L) F4U (UEA,UEB,UEE,U6234,U6235)

(ii) Int Cl (Edition 5) F24H 7/00 7/02 7/04
F24J 2/34, 3/00

Search Examiner

ALEXANDER G SMITH

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASES: WPI

Date of Search

22 MARCH 1993

Documents considered relevant following a search in respect of claims

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 1538533 (CIBA-GEIGY) see lines 20-25 on page 1 and lines 33-35 on page 2 Note that reference numerals 15, 15a, 15b in the figure do not match the text	1,2,3, 5,6
X	US 4504402 (CHEN) see layer 20 and lines 27-45 in column 8 in particular	1,5,7
	WPI Abstract Accession No 89-324574/45 and CA 1261696 (CANA)	1

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).